

DRAFT Yellow Perch (*Perca flavescens*) Thermal Tolerance Analyses – Juvenile and Adult, Summer January 2016

Introduction

Recommended summer chronic and acute thermal tolerance values for juvenile and adult yellow perch and their justification are discussed below. The recommended tolerance values were developed in accordance with the “*DRAFT Methodology for Developing Thermal Tolerance Thresholds for Various Fish in Nevada – Juvenile and Adult, Summer*” (September 2015).

Chronic Thermal Tolerance Thresholds

Table 1 provides a summary of the range of chronic temperature tolerance values for yellow perch for various lines of evidence. These values are based upon a review of 15 papers and publications, the details of which are summarized in Attachment A.

There is obviously a wide range of temperatures from which to select an appropriate value and best professional judgment is called for. NDEP’s approach is to accept the EPA recommendations from Brungs and Jones (1977) unless the literature review provides a compelling reason to utilize other values. EPA’s chronic value of 29°C falls within the upper end of the range of potential criteria found in the literature, and is recommended as the chronic thermal tolerance level for adult/juvenile yellow perch. As discussed in the methodology, chronic temperature criteria are generally not set to ensure the most optimum conditions. In fact, Brungs and Jones (1977) recommends chronic criterion for a given fish species that is between the optimum temperature and the UUILT.

Table 1. Summary of Chronic Temperature Tolerances

Category	Temperature (°C)
Laboratory Optimal Growth Studies – Constant Temperature	
Optimum	22 – 28
Upper Optimum	30
Laboratory Temperature Preference Studies	
Average Preferences	17.5 – 29
Final Preferendum	19.9 – 24.2
Laboratory Upper Temperature Avoidance Studies	26.5 – 29
Temperature Preference Field Studies	16 – 29.1
Thresholds from EPA and Colorado (MWAT)	29 – 25.2
Recommended Chronic Temperature Tolerance	29

Acute Thermal Tolerance Thresholds

Table 2 provides a summary of the range of acute temperature tolerance values for yellow perch for various lines of evidence. These values are based upon a review of 8 papers and publications, the details of which are summarized in Attachment B.

For ease of presentation, the UILT values have been summarized by acclimation temperature ranges (no studies were found which examined the Critical Thermal Maximum of juvenile/adult yellow perch. However as discussed in the methodology document, only the UILT values for acclimation temperature near the recommended chronic criterion (29°C) are to be included in the acute criterion development process. For yellow perch, UILT values for acclimation temperatures 25 – 30°C are utilized for criterion development.

Table 2. Summary of Acute Temperature Tolerances

Category	Temperature Tolerances (°C)	Potential Acute Criteria (°C)
Laboratory Lethal Studies – UILT/UILT		
UILT		
Acclim. = 5 – 10°C	21.3 – 29.0	
Acclim. = 10 – 15°C	25.0 – 29.0	
Acclim. = 15 – 20°C	27.7	
Acclim. = 20 – 25°C	29.2 – 32.3	
Acclim. = 25 – 30°C	29.7 – 32.3	27.7 – 30.3 ¹
UILT	NA	NA
Thresholds from Colorado	28.4	
Recommended Acute Temperature Tolerance	30	

¹UILT values reduced by 2°C to provide 100% survival (See *Methodology*)

A review of laboratory and field studies suggest that an appropriate acute criteria should fall between 27.7 and 30.3°C. NDEP's approach is to accept the EPA recommendations from Brungs and Jones (1977) unless the literature review provides a compelling reason to utilize another value. However, no acute recommendation was provided by EPA for yellow perch. With a chronic thermal tolerance value of 29°C, it is recommended that a slightly higher acute thermal tolerance level of 30°C be used for juvenile/adult yellow perch.

References

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ATTACHMENT A

Detailed Summary of Chronic Thermal Tolerance Values for Yellow Perch, Juvenile and Adult, Summer

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Table A-1. Chronic Temperature Tolerances – Laboratory Optimal Growth Studies

Reference	Age or Size	Acclim. Temp. (°C)	Optimum Growth Temperature		Upper Optimum Growth Temperature	
			Temp. (°C)	Comment	Temp. (°C)	Comment
Huh et al. (1976)	1.5 g	22	22 ¹			
McCormick (1976)	YOY	21	28 ²		30 ²	
Schneider (1973)	5.2-23.7 g	Unknown	23			

¹Only two temperatures were studied, 16°C and 22°C.

²Absolute growth rates peaked at 28°C, but were not significantly less ($P>0.05$) over the range from 26°C to 30°C.

Table A-2. Chronic Temperature Tolerances – Laboratory Preference Studies

Reference	Age or Size	Acclim. Temp. (°C)	Average Preference Temperature		Upper Preference Temperature		Final Preferendum	
			Temp. (°C)	Comment	Temp. (°C)	Comment	Temp. (°C)	Comment
Barans and Tubb (1973)	Underyearling	23 ¹	28 – 29 ²					
	Adult		23 – 26 ²					
Ferguson (1958)	Fingerling	8	17.5				24.2	
		10	20.6					
		15	24.5					
		20	21.5					
		25	24					
		30	26.5					
McCauley and Read (1973)	Juvenile	24	20.0 – 24.0					
	Adult		18.0 – 20.0					
Neill et al. (1972)	Juvenile		20 – 28					
Neill and Magnuson (1974)	<1 year 82-118 mm	20 – 22	23 ³					
Reutter and Herdendorf (1974 and 1976)	Adult	Unknown ³					19.9 – 20.9 ⁴	
Reynolds and Casterlin (1979)	Yearling	20	21.5 ⁵	Diurnal mean preferred temperature				

¹Acclimation temperature approximated from Figure 1 in Barans and Tubb (1973).

²The most frequently occupied temperatures, indicated by the range in 80% of the modal temperatures (°C) selected within the gradient during the summer.

³Preferred range midpoint. Median lower turnaround temperature = 21.5°C and median upper turnaround temperature = 26.5°C approximated from Figure 17.

⁴The water temperature in the acclimation tank was maintained as close to lake temperature as possible (usually within 2°C of lake temperature).

⁵Final preferenda: fall study = 19.9°C, summer study = 20.9°C, and winter study = 14.1°C. Reutter and Herdendorf (1974) found that winter preferenda were several degrees lower than summer preferenda.

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Table A-3. Chronic Temperature Tolerances – Laboratory Upper Temperature Avoidance Studies

Reference	Age or Size	Acclim. Temp. (°C)	Temperature (°C)	Comment
Neill and Magnuson (1974)	<1 year 82-118 mm	20 – 22	26.5 ¹	Median upper turnaround temperature during the day
			25	Median upper turnaround temperature during the night
			29	Upper turnaround temperature

¹Yellow perch avoided temperatures higher than 26.5 C; they kept their environment decidedly cooler than did bluegill, black crappie, carp and largemouth bass.

Table A-4. Chronic Temperature Tolerances – Field Studies

Reference	Temperature (°C)	Comment
Eaton et al. (1995)	29.1	Based upon 95 th percentile of 5% highest weekly average temperatures.
Engel and Magnuson (1976)	16 – 22	
Michaud (1981)	8 – 18	Majority found in 8 – 18°C range. Found at temperatures as low as 0°C and as high as 22°C.

Table A-5. Chronic Temperature Tolerances – EPA and Colorado

Reference	Temperature (°C)	Comments
EPA (1977)	29	Recommended level as MWAT
Colorado WQCD (2007)	25.2	Recommended level as MWAT

ATTACHMENT B

Detailed Summary of Acute Thermal Tolerance Values for Yellow Perch, Juvenile and Adult, Summer

DRAFT

Table B-1. Acute Temperature Tolerances – Laboratory Lethal Temperatures, UILT/UIILT

Reference	Size or Age	Acclim. Temp. (°C)	Test Duration	UILT		UIILT	
				Temp. (°C)	Comment	Temp. (°C)	Comment
Black (1953)	2.0-50.5 g	22 – 24	24 hours	29.2			
Blahm and Parente (1970)	Juvenile	19	143.5 minutes	32			
Brett (1944)	4.93 inches	25 – 26 ¹	1-d	30.9			
Hart (1947)	Adult	5	190-5000 minutes	21.3			
		10		25.0			
		15		27.7			
		25		29.7			
Hart (1952)		25	790 minutes	32.3			
Hathaway (1927)	1-2 years	10	1-d	29			
		21		29.6			
		30		30.3			
McCormick (1976)	Young of year	21	7-d	32 - 34 ²			

¹By indirect calculation, from knowledge of the relation of the lethal temperature to the acclimation temperature in the bullhead, the probable temperature acclimation for these twelve fish was in the region of 25°C to 26°C.

²No fish held at 32°C for 7 days died. All fish held at 34°C for 7 days died. Therefore, 50% mortality level considered to lie between 32 and 34°C

Table B-3. Acute Temperature Tolerances – Colorado

Reference	Temperature (°C)	Comments
Colorado WQCD (2007)	28.4	Recommended level as DM